CLAIMS

WE CLAIM AS OUR INVENTION:

1. A material adapted for use in a high temperature environment comprising:

an oxide-oxide ceramic matrix composite material;

a layer of ceramic insulating material bonded to a surface of the ceramic matrix composite material, the insulating material further comprising:

a plurality of hollow particles, each particle in contact with at least one other of the particles; and

an aluminum hydroxyl chloride binder at least partially filling gaps between the particles.

2. The material of claim 1, further comprising an oxide filler material dispersed among the particles, the binder at least partially filling gaps between the particles and the filler material.

3. The composite material of claim 1, wherein the particles comprise a close packed array of hollow oxide-based spheres with each sphere in contact with a plurality of other of the spheres.

4. The composite material of claim 1, wherein the particles each comprise a hollow sphere formed of a wall material comprising 82% mullite spheres and 18% alumina.

5. The composite material of claim 1, further comprising a layer of adhesive disposed between the ceramic matrix composite material and the ceramic insulating material.

6. The composite material of claim 1, wherein the ceramic matrix composite material comprises fibers comprising alumina and silica disposed in an alumino-silicate matrix.

7. The composite material of claim 1, wherein the ceramic matrix composite material comprises fibers comprising alumina and silica disposed in an alumina matrix.

8. A material adapted for use in a high temperature environment comprising:
a plurality of hollow oxide-based particles of various dimensions;
an aluminum hydroxyl chloride binder at least partially filling gaps between the particles;
whereby the particles are situated in the binder such that each particle is in contact with at least one other particle.

9. The material of claim 8, further comprising an oxide filler material dispersed among the particles, the binder at least partially filling gaps between the particles and the filler material.

10. The material of claim 8, wherein the particles comprise a close-packed array of hollow oxide-based spheres.

11. The material of claim 8, wherein the particles each comprise a hollow sphere formed of a wall material comprising 82% mullite spheres and 18% alumina.

12. A method of forming a composite structure for use in a high temperature environment, the method comprising:
processing a green body ceramic matrix composite material to a predetermined partially cured state;
applying a wet ceramic insulating material to the partially cured ceramic matrix composite material; and
co-firing the partially cured ceramic matrix composite material and the ceramic insulating material together to form a sinter bond there between;
wherein the predetermined partially cured state of the ceramic matrix composite material is selected to control relative shrinkage between the ceramic matrix composite material and the ceramic insulating material during the co-firing step.

13. The method of claim 12, further comprising processing the green body ceramic matrix composite material to a state wherein shrinkage of the partially cured ceramic matrix composite material and shrinkage of the ceramic insulating material are within ±0.05% of each other during the co-firing step.

14. The method of claim 12, further comprising processing the green body ceramic matrix composite material to a state wherein shrinkage of the partially cured ceramic matrix composite material and shrinkage of the ceramic insulating material are within ±0.1% of each other during the co-firing step.

15. The method of claim 12, further comprising processing the green body ceramic matrix composite material to a state wherein shrinkage of the partially cured ceramic matrix composite material and shrinkage of the ceramic insulating material are within ±0.25% of each other during the co-firing step.

16. The method of claim 12, further comprising processing the green body ceramic matrix composite material to an extent necessary to essentially match shrinkage of the partially cured ceramic matrix composite material to shrinkage of the ceramic insulating material during the co-firing step.

17. The method of claim 12, further comprising processing the green body ceramic matrix composite material to a state wherein shrinkage of the partially cured ceramic matrix composite material is no more than shrinkage of the ceramic insulating material during the co-firing step.

18. The method of claim 12, further comprising processing the green body ceramic matrix composite material to a predetermined state that achieves a selected degree of shrinkage mismatch between the ceramic matrix composite material and the ceramic insulating material during the co-firing step.

19. The method of claim 12, further comprising:

forming the green body ceramic matrix composite material to comprise ceramic oxide reinforcing members in an aluminosilicate matrix material; and

forming the wet ceramic insulating material to comprise an aluminum hydroxyl chloride binder material.

20. The method of claim 12, further comprising:

forming the green body ceramic matrix composite material to comprise ceramic oxide reinforcing members in an alumina material; and

forming the wet ceramic insulating material to comprise an aluminum hydroxyl chloride binder material.

21. The method of claim 12, further comprising premixing wet ceramic insulating material and applying the premixed material to the partially cured ceramic matrix composite material.

22. The method of claim 12, wherein the step of applying further comprises:

applying a close-packed array of particles against the partially cured ceramic matrix composite material; and

infusing the close-packed array with a matrix binder material.

23. The method of claim 12, further comprising applying a layer of a ceramic adhesive material to the partially cured ceramic matrix composite material prior to the step of applying the wet ceramic insulating material composition.

24. The method of claim 12, further comprising:

forming the ceramic matrix composite material to comprise oxide fibers and oxide matrix material;

bisque firing the ceramic matrix composite material to the partially cured state at a temperature above 400 °C. to achieve a desired degree of shrinkage of the ceramic matrix composite material prior to the step of applying wet ceramic insulating material.

25. The method of claim 12, further comprising bisque firing the ceramic matrix composite material to the partially cured state at a temperature above 1,100 °C. to achieve a desired degree of shrinkage of the ceramic matrix composite material prior to the step of applying wet ceramic insulating material.

26. A material adapted for use in a high temperature environment comprising:

a plurality of hollow oxide-based particles of various dimensions;

an alumina sol binder at least partially filling gaps between the particles;

whereby the particles are situated in the binder such that each particle is in contact with at least one other particle.